Comparison of 6 different gutta-percha techniques (part II): Thermafil, JS Quick-Fill, Soft Core, Microseal, System B, and lateral condensation

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Objectives. In this in vitro study, the core-to-sealer ratios were calculated for 6 different gutta-percha techniques: Thermafil, JS Quick-Fill, Soft Core, Microseal, System B, and lateral condensation. The core consisted of gutta-percha or gutta-percha and carrier.

Study design. The sealer-to-core ratios for the Thermafil, JS Quick-Fill, System B, and lateral condensation techniques were published previously. In this study, the sealer-to-core ratio for Microseal and Soft Core techniques was investigated. For this purpose, 20 teeth filled by using the Soft Core or the Microseal technique were embedded in resin and sectioned horizontally at 1, 2, 3, and 4 mm from the anatomic apex. Photographs were taken of each section, and the total area of the canals filled with core material or sealer was calculated.

Results. Once all results were compiled, it became clear that core techniques (Thermafil, JS Quick-Fill, and Soft Core) produced higher gutta-percha content than the Microseal, System B, and lateral condensation techniques ($P < .05$). The lateral condensation technique produced the least gutta-percha content ($P < .05$).

Conclusion. Thermafil, JS Quick-Fill, and Soft Core were found to be superior to the Microseal, System B, and lateral condensation techniques in terms of the gutta-percha-to-sealer ratio.

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At the conclusion of endodontic therapy, the root canal space, including the patent accessory canals and multiple foramina, must be completely and densely filled with a biologically inert material.[1] Furthermore, the integrity of the root canal filling in the apical few millimeters is believed to be one of the criteria necessary to ensure successful endodontic treatment.[2] Most obturation methods make use of a solid core material cemented into the canal with a sealer. Previous studies have shown that most endodontic sealers are soluble[3-7] and some may shrink slightly.[8-12] Sealer dissolution may trigger an increase in leakage along the root fillings over time.[7] Therefore, reducing the ratio of sealer to gutta-percha may improve the long-term seal provided by the root canal filling.[13] Lateral condensation of gutta-percha is one of the most accepted canal obturation methods and is taught by many dental schools. However, its ability to adapt to the internal surface of the root canal has been questioned. Brayton et al[14] reported voids, spreader tracts, incomplete fusion of the gutta-percha cones, and lack of surface adaptation with the use of this technique. In addition, this technique relies on sealer to fill accessory canals. Eguchi et al[15] reported that lateral condensation results in excessive amounts of sealer and apical voids. Peters[3] demonstrated that some sealers used in lateral condensation might resorb with time. This might decrease the effectiveness of the root canal obturation.

Studies have shown that plasticized gutta-percha can easily be moved into the canal irregularities, thus replicating the intricacies of the root canal system. There are a number of methods that make use of plasticized gutta-percha. These include warm lateral condensation, warm vertical condensation, coated carrier systems, injection systems, and thermomechanical compaction.

Because all new gutta-percha condensing techniques have been developed to minimize the sealer and maximize the gutta-percha content, there have been few studies reporting the absolute gutta-percha content achievable with these techniques. In a previous study,[16] my coauthors and I evaluated the gutta-percha content of Thermafil, JS Quick-Fill, System B, and lateral condensation; we found the core techniques to be superior to the System B and lateral condensation techniques.

Soft Core (Soft Core System, Copenhagen, Denmark)[17] and Microseal (Tycom, Irvine, Calif) are 2 new obturation systems for which the sealer-to-core ratios are unknown. Soft Core consists of biocompatible plastic carrier coated with thermoplastic α-phase gutta-percha. The central plastic core of Soft Core is round and hollow. The Microseal system is a thermoplastic technique that makes use of a master gutta-percha cone that is first compacted laterally with a spreader, after

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which thermoplasticized gutta-percha is delivered and compacted with a rotary compactor. This will plasticize all gutta-percha into 1 homogeneous filling.[18]

The objective of this study was to determine the sealer-to-core ratios of root canal fillings achieved with Soft Core and the Microseal techniques and to evaluate the results from these 2 systems in light of the results from the earlier study of Thermafil, Quick-Fill, System B, and lateral condensation.

MATERIAL AND METHODS

Twenty upper incisors with straight root canals were selected. A No. 10 K-file was inserted to determine the exact location of the apical foramen. In any specimen in which the anatomic foramen was short of the anatomic apex, the apical cementum and dentin were removed so that the anatomic foramen was at the true terminus of the root. Then the crowns were removed, and each tooth was adjusted to 18 mm in length. The teeth were instrumented with a No. 60 master apical file by means of the step-back technique. The root canals were irrigated with 5.25% sodium hypochlorite between each change of instrument and dried with paper points. The teeth were randomly assigned into 2 groups of 10 teeth each.

In the first group, the root canals were obturated by using the Microseal system. The size of the master cone was adjusted until tug-back was confirmed. The appropriate spreader was selected to compact the master cone of gutta-percha 1.0 mm short of the working length. Finally, the additional appropriate mechanical compactors were selected according to the manufacturer's instruction. Kerr sealer was placed into the canal, and the sealer-coated master gutta-percha cone was seated. The spreader was inserted along the master cone at the appropriate length for compaction. On the withdrawal of the spreader from the canal, a tapered void had formed between the compacted gutta-percha cone and the root canal walls. The appropriate compactor was inserted in the heated gutta-percha cartridge and was coated with a uniform layer of material. The gutta-percha–coated compactor was then immediately carried to the void previously created in the canal by the spreader and was placed as close to the working length as possible, with care taken to prevent rotation as it was inserted. With the application of a resisting force to the compactor's backing-out motion, but without any apical pressure, the rotation of the compactor began at a speed of 6000 rpm. After approximately 2 seconds, the compactor was removed slowly while being softly pushed against 1 side of the canal. Rotation did not stop until the compactor was fully removed from the canal. If the canal was not completely filled, more gutta-percha was placed on the compactor. Excess gutta-percha and sealer were removed from the access cavity.[18,19]

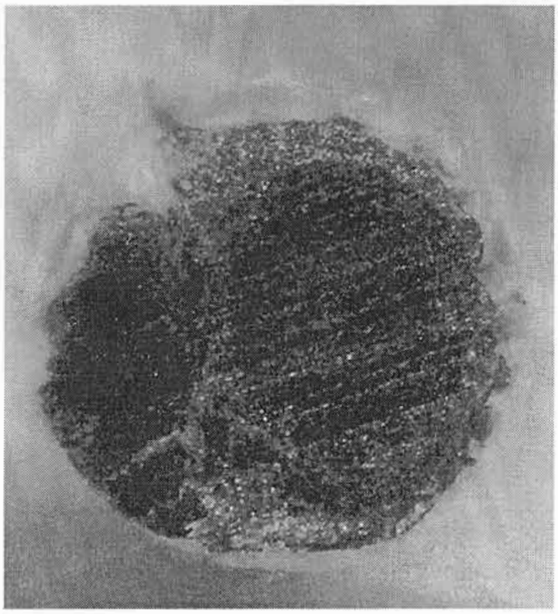

Fig 1. Representative photograph of a canal obturated by using the Soft Core technique at the fourth section.

In the second group, the root canals were obturated with Soft Core. On the basis of the information obtained from a "size-verifier," a No. 60 Soft Core obturator was selected and heated. The root canal was coated with Kerr sealer, and the plasticized Soft Core device was inserted to the apical stop. Then the handle and insertion pin were removed, and excess plastic core was cut away with a small inverted cone bur.[17]

After the root fillings were completed, the teeth were stored for 7 days at room temperature and 100% humidity to ensure the setting of all materials. The teeth were embedded in clear orthodontic resin. A rotary saw with a diamond blade was used to make cross-sectional slides through the embedded teeth.[15] To reduce smearing of the gutta-percha, the saw was cooled by using cold-water irrigation. The roots were sectioned at 1, 2, 3, and 4 mm from the anatomic apex. A stereomicroscope was used to take photographs of each section at an original magnification of ×2 (Figs 1 and 2). The canal outlines and gutta-percha margins were traced onto clear acetate. Acetate copies were scanned, and the peripheries of all areas of sealer, gutta-percha, and voids were calculated by using the AutoCAD system (Autodesk Inc, San Rafael, Calif) with an LED cursor and a personal computer (IBM Corporation, Armonk, NY). For the purposes of calculating the sealer-to–solid core material ratio, areas of gutta-percha and metal or

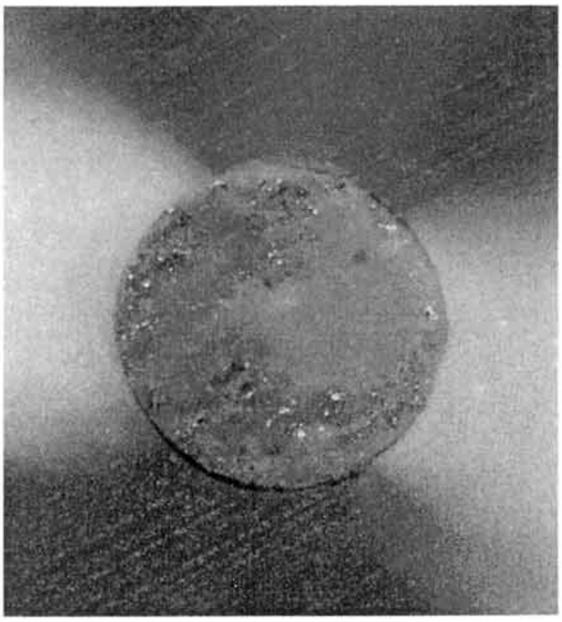

Fig 2. Representative photograph of a canal obturated by using the Microseal technique at the fourth section.

plastic carrier were combined for Thermafil, Soft Core, and JS Quick-Fill specimens. All measurements were evaluated by using 1-way analysis of variance and Newman-Keuls tests.

RESULTS

The data obtained in the previous study[16] and in this study indicate that all core techniques (Thermafil, JS Quick-Fill, and Soft Core) produced a higher ratio of gutta-percha to sealer than the Microseal, System B, and lateral condensation techniques ($P < .05$). Of the core techniques, Thermafil produced the highest ratio of gutta-percha to sealer. The difference, however, was not significantly different from that obtained with JS Quick-Fill or Soft Core ($P > .05$). The lateral condensation technique had the lowest ratio of gutta-percha to sealer ($P < .05$). There was no other significant difference between the System B and Microseal techniques ($P > .05$) (Table).

DISCUSSION

This study found that the core gutta-percha techniques result in a higher gutta-percha–to-sealer ratio than vertical, cold, and warm lateral condensation techniques. However, all warm condensation techniques produced a higher gutta-percha–to-sealer ratio than the cold lateral condensation technique.

Wu et al[20] found that the thickness of the sealer layer influenced the sealing ability of the root canal filling; furthermore, gross leakage was detected when zinc oxide–eugenol sealer was 0.25 to 3 mm thick. In the literature, the thermomechanical, vertical, and lateral condensation techniques have been used to evaluate gutta-percha content. There have been few studies on the other techniques. Recently, Silver et al[21] reported that System B fillings contained more than 90% gutta-percha. In a previous study,[22] my coauthors and I reported core contents of 91.2% with the Thermafil technique and 78% with the lateral condensation technique. In another study, Wu et al[23] evaluated the percentage of sealer-coated canal perimeter in the apical and middle regions of canals filled by using the single-cone, lateral, and vertical condensation techniques and reported this percentage to be significantly higher in both regions for the single-cone (no-condensation) group than for the others. However, they found that the percentage of sealer-coated canal perimeter was significantly higher in the lateral condensation group than in the vertical condensation group at 6 mm from the apex. In this study, I discovered that all core techniques resulted in significantly more gutta-percha content than did the lateral condensation technique. Other than the core techniques, some warm gutta-percha techniques also produced higher gutta-percha content than did the cold lateral condensation technique. Although Thermafil produced greater total core content than other core techniques, the difference was not significant.

In the literature, the techniques have usually been compared on the basis of their leakage patterns. Beatty et al,[24] Gençoğlu et al,[25,26] and Dummer et al[27] found that the use of the Thermafil technique resulted in less leakage than did the lateral condensation technique. More recently, Kytridou et al[28] found that both the Thermafil technique and the System B technique produced substantial material movement in the canal irregularities. Pommel and Camps[29] investigated apical leakage of the single-cone, lateral condensation, vertical condensation, Thermafil, and System B techniques by using a fluid filtration system, taking measurements at 24 hours and 1 month. They found that the single-cone technique produced the most apical leakage in 24 hours. They indicated that this result was attributable to the greater volume of sealer required for the single-cone technique. After 1 month, they found that the Thermafil, System B, and vertical condensation techniques produced less leakage than did the 2 other techniques. The lateral condensation technique produced more apical leakage after 1 month, whereas the single-cone technique produced the greatest leakage. It seemed that the use of a larger volume of sealer, as was the case with the single-cone and lateral condensation techniques, results in shrinkage more often than does

Table. Percentages of the canal areas filled by gutta-percha with the use of 6 gutta-percha techniques

		Distance from apex			
Techniques	*Mean*	*1 mm*	*2 mm*	*3 mm*	*4 mm*
Thermafil*					
Mean ± SD	98.85 ± 2.96	99.8 ± 0.60	99.25 ± 2.56	98.50 ± 4.10	97.83 ± 6.31
QuickFill*					
Mean ± SD	96.23 ± 7.98	99.35 ± 1.47	98.36 ± 2.56	96.69 ± 3.49	91.42 ± 4.66
Soft Core					
Mean ± SD	96.38 ± 7.21	99.15 ± 1.88	98.14 ± 4.55	97.19 ± 5.27	89.94 ± 10.71
System B*					
Mean ± SD	86.74 ± 0.27	86.69 ± 11.22	80.84 ± 15.75	89.61 ± 1.12	90.52 ± 4.42
Microseal					
Mean ± SD	89.13 ± 12.39	91.91 ± 12.7	95.09 ± 4.62	79.64 ± 16.36	90.76 ± 7.10
Lateral condensation*					
Mean ± SD	81.21 ± 0.87	73.99 ± 21.57	82.66 ± 13.14	86.26 ± 1.12	81.85 ± 2.19
1-way ANOVA	$F = 16.79$ $P < .0001$	$F = 8.18$ $P < .0001$	$F = 7.95$ $P < .0001$	$F = 7.38$ $P < .001$	$F = 7.38$

ANOVA, Analysis of variance.
*Data were obtained from the previous study.[16]

the use of a small volume, as was the case with the compaction techniques.

Davalou et al[19] reported no significant difference in apical leakage between the System B and Microseal techniques. However, Hwang et al,[30] investigating the sealing ability of isthmuses by using the Microseal and lateral condensation techniques, discovered that the Microseal technique was superior to the lateral condensation technique.

Leung et al[31] compared density and wall adaptation by using the warm vertical condensation, Microseal, and lateral condensation techniques, finding that the warm vertical condensation technique was slightly better than other 2 techniques. In this study, the Microseal technique was superior to the lateral condensation technique, but the difference was not significant between System B and Microseal with regard to gutta-percha content.

De Moor and Martens[32] reported that both the hybrid condensation technique and the lateral condensation technique result in less apical leakage than the Soft Core technique. In other studies, De Moor and Hommez[33] and De Moor and De Boever[34] evaluated the sealing ability of the warm vertical condensation, hybrid condensation, Thermafil, and Soft Core techniques, finding that hybrid condensation was superior to the other techniques. In this study, the hybrid condensation technique was not investigated. All core techniques were superior to the warm condensation technique when evaluated in terms of gutta-percha content.

Shakespeare and Donnelly[35] and Gulabivala et al[36] found less leakage with the use of the lateral condensation technique than with the JS Quick-Fill technique, whereas Pallares and Faus[37] and Canalda-Sahli et al[38] found no statistical difference. In our previous study,[16] less leakage occurred with the use of the JS Quick-Fill technique than with the lateral condensation technique. The use of JS Quick-Fill with a retained carrier may further decrease the leakage.

In terms of gutta-percha content, I found all carrier and warm gutta-percha techniques to be superior to the lateral condensation technique.

Although these are in vitro results, they are of significance because these factors cannot easily be quantitatively determined in vivo. Nevertheless, further clinical studies are necessary to confirm these results and evaluate their relevance to treatment outcome.

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